Decision Rationale

Total Maximum Daily Load for
Fecal Coliform for Willis River

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDL for fecal coliform for Willis River. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The 177,936 acre Willis River watershed is located in Cumberland and Buckingham Counties. The TMDL addresses a 14.3 mile stream stretch, beginning at Willis River's confluence with Reynolds Creek and terminating at its confluence with the James River. Forest (75%) and agricultural lands (21%) make up approximately 96% of the 178,000 acre watershed.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 14.3 miles of Willis River as being impaired by elevated levels of fecal coliform on Virginia's 1996 Section 303(d) list. The water stayed on the Virginia's1998 Section 303(d) list as well. Willis River was listed for violations of Virginia's fecal coliform bacteria

water quality standard. Fecal coliform is a bacterium which can be found within the

intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA has been encouraging the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth plans on adopting the e-coli and enterococci standards in 2002.

As Virginia designates all of its waters for primary contact, all waters must meet the current fecal coliform standard for primary contact. Virginia's standard applies to all streams designated as primary contact for all flows. Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the fecal coliform standard. Thus, many of Virginia's TMDLs have called for some reduction in the amount of wildlife contributions to the affected streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In Phase 1of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact. The Commonwealth will also investigate incorporating a natural background condition for the bacteriological indicator.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation rate associated with the wildlife loading may be smaller than the percent error of the model or the MOS. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

Willis River identified as watershed VAP-H36R, was given a high priority for TMDL development. Section 303(d) of the CWA and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the state where technology-based and other controls do not provide for the attainment of water quality standards. The TMDL submitted by Virginia is designed to determine the acceptable load of fecal coliform which can be delivered to Willis River, as demonstrated by the Hydrologic Simulation Program Fortran (HSPF)[1], in order to ensure that the water quality standard is attained and maintained. HSPF is considered an appropriate model to analyze this watershed because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to all of the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[2] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. These wastes do not need a transport mechanism to allow them to reach the stream. The allocation plan calls for the reduction in fecal coliform wastes delivered by cattle in-stream, wildlife in-stream, and straight pipes.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL	WLA (cfu/yr)	LA (cfu/yr)	MOS (cfu/yr)*
Total	Fecal Coliform	1.42E+16	3.12E+11	1.42E+16	2.42E+12

*Virginia includes an explicit MOS by identifying the TMDL target as achieving the total fecal coliform water quality concentration of 190 cfu/100ml as opposed to the WQS of 200 cfu/ml. This can be viewed explicitly as a 5% MOS.

EPA believes it is important to recognize the conceptual difference among the waste load allocation (WLA) values, load allocation (LA) values for sources modeled as direct deposition to stream segments, and LA values for flux sources of fecal coliform to land use categories. The WLA values and LA values for direct sources represent amounts of fecal coliform which are actually deposited into the stream segments. The HSPF model, which considers landscape processes which

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[1]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

[2]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

affect fecal coliform runoff from land uses, determines the amount of fecal coliform which reaches the stream segments. The LA in Table 1 is the amount of colony forming units (cfu) reaching the stream from nonpoint sources annually.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a fecal coliform TMDL for Willis River. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality standards and designated uses on Willis River. The water quality criterion for fecal coliform is a geometric mean 200 cfu/100mL or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a 30 day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a 30 day period, most of the samples are measured against the instantaneous standard. Eighteen of the 155 samples (12%), collected from 1972 through 2001, from the six major sampling stations (more than one sampling point) violated the instantaneous standard. Approximately 70% of the samples collected from the major sampling stations during this time period had fecal coliform concentrations at or below 200 cfu/100 mL. Based on the data, it appears as though Willis River is nearly attaining the instantaneous fecal coliform water quality standard. It is important to note that the data was taken over a 29-year period, meaning an average of five samples were taken from the stream annually. The data is not nearly extensive enough to document the stream's compliance with the geometric mean.

The modeling for Willis River was done to measure the stream's compliance with the geometric mean standard. The observed stream data had the highest concentrations of fecal coliform occurring during the winter months (specifically January and December). These months had some of the lowest fecal coliform concentrations during the simulations. With so few samples, it is difficult to determine if the observed data represented isolated incidents or a long term trend. This issue should be revisited by the Commonwealth during subsequent monitoring.

The HSPF model is being used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from point and other direct deposit sources necessary to support the fecal coliform water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of fecal coliform to Willis River will ensure that the criterion is attained.

The TMDL modelers determine the fecal coliform production rates within the watershed. Data used in the model was obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, land uses, weather, stream geometry, etc.. The model then combines all the data to determine the hydrology and water quality of the stream.

Calibration is the process of comparing modeled data to observed data and making appropriate adjustments to model parameters to minimize the error observed and simulated events.[3] United States Geologic Survey gage data was available form gage #2034500 on Willis River. This gage measured mean daily discharge from October 1953 through December 1986. The hydrologic calibration was run using mean daily flow data from January 1983 through December 1986. The model was run over an hourly time step and resulting flows were averaged for each day, for comparison to the monitored values.[4] Calibration may have been made more difficult based on the nature of the gage data. Several parameters including the evapotranspiration rate, recession rates to groundwater and interflow, storage capacity within the subsurface and surface zones, slope, and forest cover were adjusted to insure that the calibration closely represented the observed data. The model over represented the flow regimes in many of the hydrology calibration parameters. The summer storm volume was severely over represented in the model.

In order to insure that the calibration is representing actual conditions properly, the model was transferred to a different time period and run without adjusting the hydrologic parameters. The hydrologic model for Willis River was validated against observed data from January 1979 through December 1982. Problems associated with the hydrologic calibration may compound problems when trying to model the water quality of a steam.

The TMDL did not apply any reductions to land based sources (other than straight pipes) even though they provided the majority of the fecal coliform loading to Willis River. This is due to the nature of the geometric mean standard. The geometric mean is designed to diminish the impact of a small number of extremely large samples on a data set. Therefore, the geometric mean is most impacted by the conditions that occur with a greater frequency. Since baseflow events occur far more often, it was necessary to develop an allocation scenario that attains the standard during these flow regimes. These flow regimes are impacted by direct deposit sources; that is why the allocations focused on these sources.

EPA believes that using HSPF to model and allocate fecal coliform will ensure that the

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[3]Maptech, 2002. Fecal Coliform TMDL Development for Catoctin Creek Impairments, Virginia. April 23, 2002.

[4]Maptech, 2002. Fecal Coliform TMDL Development for Willis River, Virginia. April 26, 2002.

designated uses and water quality standards will be attained and maintained for Willis River.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading of fecal coliform is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest, commercial, mixed urban, cropland, poultry operation, farmstead, improved pasture, unimproved pasture, unmanaged grassland, grazed woodland, wooded residential, low and medium density residential, wetlands, harvested forest, and livestock access), directly deposited nonpoint sources of fecal coliform (cattle in-stream, wildlife in-stream, and lateral flow), and point sources. Activities such as the application of manure and the direct deposition of wastes from grazing animals are considered fluxes to the land use categories. The actual value for the total fecal load can be found in Table 1of this document. The total allowable load is calculated on an annual basis due to the nature of HSPF model.

Waste Load Allocations

Virginia has stated that there are two point sources, Bear Creek Sewage Treatment Plant (STP) and Dillwyn Wastewater Treatment Plant (WWTP) in the Willis River watershed. The facilities are permitted to discharge their effluent with a fecal coliform concentration of 200 cfu/100 mL. Bear Creek STP and Dilwyn WWTP are permitted to discharge at a rate 0.013 and 0.1 million gallons per day (MGD) respectively. Their WLA was determined by multiplying their allowable concentration (200 cfu/100 mL) by their permitted flow (0.013 or 0.1 mgd) by the number of days in a year (365). It should be noted that chlorination requirements will in all likelihood reduce fecal coliform concentrations in the effluent to levels substantially lower than the permitted limit.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2 - Waste Load Allocations for Willis River

Facility	Permit Number	Existing Discharge	Allocated Discharge
Bear Creek STP	VA0028266	3.59E+10	3.59E+10
Dilwyn WWTP	VA0027294	2.76E+11	2.76E+11

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the Willis River watershed. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint loadings, and receiving water quality for conventional pollutants and toxicants[5]. HSPF uses precipitation data for continuous and storm event simulation to determine total fecal loading to Willis River from forest, commercial, mixed urban, cropland, poultry operation, farmstead, improved pasture, unimproved pasture, unmanaged grassland, grazed woodland, wooded residential, low and medium density residential, wetlands, harvested forest, and livestock access. The total land loading of fecal coliform is the result of the application of manure, biosolids, and direct deposition from cattle, other livestock and wildlife (geese, deer, etc.); the deposition of fecal coliform from failed septic systems and fecal coliform production from pets. In the Willis River TMDL, straight pipes were modeled as discharging to the land based on information received by the Department of Health.

In addition, VADEQ recognizes the significance of fecal coliform from cattle in-stream, lateral flow, and wildlife in-stream. These sources are not dependent on a transport mechanism to reach a surface waterbody, and therefore, can impact water quality during low and high flow events. Please note that all of the values in Table 3, other than the direct deposit nonpoint sources (cattle in-stream, wildlife in-stream, and lateral flow), are given in terms of cfu to the land surface. The amount of waste from these land uses (forest, commercial, mixed urban, cropland, poultry operation, farmstead, improved pasture, unimproved pasture, unmanaged grassland, grazed woodland, wooded residential, low and medium density residential, wetlands, harvested forest, and livestock access) reaching the stream is significantly lower. The cattle in-stream load was transferred to the loafing lot load in the allocated loadings in Table 3. This caused an increase in fecal coliform loading to the land use. The loadings from straight pipes was applied to specific residential land uses. Although the elimination of

[5] Supra, footnote 2.

this loading was called for in the TMDL, it was not quantified in the allocations because the loading associated with these discharges was negligible when compared to the land based loadings in full.

Table 3 - LA for the Land Application of Fecal Coliform

Land Use/Source	Existing Load	Allocated Load	Percent Reduction
Forest	7.32E+15	7.32E+15	0%
Commercial	1.29E+13	1.29E+13	0%
Mixed Urban	9.73E+12	9.73E+12	0%
Cropland	2.13E+15	2.13E+15	0%
Poultry Operation	8.13E+12	8.13E+12	0%
Farmstead	4.77E+13	4.77E+13	0%
Improved Pasture	1.88E+16	1.88E+16	0%
Unimproved Pasture	2.12E+15	2.12E+15	0%
Unmanaged Grassland	7.63E+12	7.63E+12	0%
Grazed Woodland	2.94E+09	2.94E+09	0%
Barren	4.37E+13	4.37E+13	0%
Wooded Residential	6.26E+12	6.26E+12	0%
Residential Low/ Medium Density	4.40E+14	4.40E+14	0%
Wetlands	9.68E+14	9.68E+14	0%
Harvested Forest	5.80E+14	5.80E+14	0%
Potential Livestock Access	2.02E+14	3.51E+14	-74%
Cattle In-stream	4.89E+13	0.0	100%
Wildlife In-stream	5.48E+13	9.31E+12	83%

Lateral Flow	5.07E+08	5.07E+08	0%

The TMDL did not apply any reductions to land based sources (other than straight pipes) even though they provided the majority of the fecal coliform loading to Willis River. This is due to the nature of the geometric mean standard. The geometric mean is designed to diminish the impact of a small number of extremely large samples on a data set. Therefore, the geometric mean is most impacted by the conditions that occur with a greater frequency. Since baseflow events occur far more often, it was necessary to develop an allocation scenario that attains the standard during these flow regimes. These flow regimes are impacted by direct deposit sources that is why the allocations focused on these sources.

3) The TMDL considers the impacts of background pollution.

A background concentration was set by determining the wildlife loading to each land segment.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Gills Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[6]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios.

The sources of bacteria for these stream segments were a mixture of dry and wet weather driven sources. Therefore, the critical condition for Willis River was represented as a typical hydrologic year. Since the stream was modeled to attain the geometric mean standard and base and low flow

[6]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

events occurred far more often (90% of the time) then wet weather events, it was essential that the standard be maintained during these periods. Therefore, base flow conditions were the more critical period. If the standard is attained during dry weather conditions, the geometric mean standard will be insulated against the variability associated with wet weather loading.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in

early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations. The model also accounted for the seasonal variation in loading. Fecal coliform loads changed for many of the sources depending on the time of the year. For example, cattle spent more time in the stream in the summer and animals were confined for longer periods of time in the winter.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL.

Virginia includes an explicit MOS by establishing the TMDL target water quality concentration for fecal coliform at 190 cfu/ 100mL, which is more stringent than Virginia's water quality standard of 200 cfu/100 mL. This would be considered an explicit 5% margin of safety. Since the TMDL was modeled to attain a geometric mean of 190 cfu/ 100mL, the direct deposit loadings were forced to be reduced even more.

Although the TMDL did not specifically call for any land based reductions, reductions to land based sources are expected to occur. Through the installation of livestock exclusion devices, stream-side buffer strips will be created. These strips will intercept and trap a portion of the storm related runoff ,thereby, reducing fecal coliform loading to the stream from wet weather events. These reductions were not quantified in the TMDL.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the

assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards. However, due to the wildlife issue that was previously mentioned, the Commonwealth believes that it may be appropriate to modify its current standards to address the problems associated with wildlife loadings.

8) The TMDLs have been subject to public participation.

Two public meetings were held to discuss TMDL development on Willis River. Both meetings were public noticed in the *Virginia Register* and *Farmville Herald*. Both meetings were subject to a 30 day public comment period. The first meeting was held on November 27, 2001 in Cumberland, VA. Approximately thirty-three people attended this initial meeting on the TMDL. One written comment was received during the initial comment period. Approximately 30 people attended the second meeting which was held in Cumberland, VA on March 07, 2002. Two written comments were received during the second public comment period.